

ELECTROSTATIC CHUCK MECHANISM AND SEMICONDUCTOR PROCESSING DEVICE

TECHNICAL FIELD

The present disclosure relates to the field of semiconductor device manufacturing, and particularly, relates to an electrostatic chuck mechanism and a semiconductor processing device.

BACKGROUND

In a process of manufacturing an integrated circuit or a micro-electro-mechanical system (MEMS), in particular, in a process of implementing plasma etching, physical vapor deposition (PVD), chemical vapor deposition (CVD), etc., an electrostatic chuck is commonly employed for bearing and heating a workpiece to be processed, such as a wafer, and the electrostatic chuck also provides a DC bias voltage to the workpiece to be processed, such as a wafer, and controls a surface temperature of the workpiece to be processed.

Fig. 1 is a schematic diagram of a structure of a typical electrostatic chuck mechanism. As shown in Fig. 1, the electrostatic chuck mechanism includes an electrostatic chuck 8 and an edge assembly. The electrostatic chuck 8 is configured to fix a wafer 5 onto its upper surface by electrostatic adsorption, and a heater is provided in the electrostatic chuck 8 to control a temperature of the wafer 5. The edge assembly includes a focus ring 6, a base ring 7 and an insulation ring 9, which are successively stacked on one another from top to bottom. The insulation ring 9 is fixed on an installing and fixing member 10 and is configured to support the electrostatic chuck 8. The focus ring 6 and the base ring 7 both surround the electrostatic chuck 8, the focus ring 6 is configured to form a boundary within which plasma can be confined; and the base ring 7 is configured to support the focus ring 6 and protect an outer peripheral wall of the electrostatic chuck 8 from being etched by the plasma.

The above-described electrostatic chuck mechanism inevitably suffers from the following problems in practical applications.

Since the beginning of the 28-20 nanotechnology generation, high K gate dielectrics and metal gate electrode MOS devices have been introduced to integrated circuit manufacturing process, and uniformity (3σ) of transistor gate lengths among wafers has decreased from 3nm for 45nm node to 1.56nm for 32nm node, which means a greatly raised requirement for etching uniformity. However, due to the limitation of the physical dimension of the electrostatic chuck 8, the heater in the electrostatic chuck 8 is unable to control temperature of the wafer 5 at the vicinity of its edge (since a diameter of the wafer 5 is slightly greater than an outer diameter of the electrostatic chuck 8, the heater cannot control temperature of a portion on the periphery of the wafer 5 that is not in contact with the electrostatic chuck 8), resulting in non-uniformity of temperature between an edge area and a center area of the wafer 5, failing to meet the 28-20 nanotechnology requirement for etching uniformity between the edge area and the center area of the wafer 5.

SUMMARY

The present disclosure is intended to at least address one of the technical problems existing in the prior art, and provides an electrostatic chuck mechanism and a semiconductor processing device, which can separately adjust temperatures of a center area and an edge area of the wafer, so that a difference in temperature between the edge area and the center area of the wafer can be compensated for, and in turn the process uniformity can be improved.

To achieve the object of the present disclosure, there is provided an electrostatic chuck mechanism, including a base and an edge assembly, wherein the base includes a bearing surface configured to bear a wafer and a step surface, which surrounds the bearing surface and is located at an edge of the wafer, the step surface being lower than the bearing surface; the edge assembly includes a focus ring, a base ring, and an insulation ring, the focus ring is disposed on the step surface in a manner of surrounding the bearing surface; the base ring is disposed to surround an outer peripheral wall of the base; the insulation ring is disposed at a bottom of the base and supports the base; the electrostatic chuck mechanism further includes a main

electrostatic heating layer and an edge electrostatic heating layer, wherein, the main electrostatic heating layer is disposed on the bearing surface, configured to electrostatically adsorb the wafer, and is able to adjust temperature of the wafer; the edge electrostatic heating layer is disposed on the step surface, configured to electrostatically adsorb the focus ring, and is able to adjust temperature of the focus ring.

The edge electrostatic heating layer includes a edge heating layer and a edge insulating layer successively disposed from bottom to top, wherein the focus ring is overlaid on the edge insulating layer, the edge insulating layer is provided therein with a first DC electrode, and electrostatic adsorbing force is generated on the focus ring by supplying DC to the first DC electrode; and the edge heating layer is configured to heat the focus ring by heat transfer.

The main electrostatic heating layer includes a main heating layer and a main insulating layer successively disposed from bottom to top, wherein the wafer is overlaid on the main insulating layer, the main insulating layer is provided therein with a second DC electrode, and electrostatic adsorbing force is generated on the wafer by supplying DC to the second DC electrode; and the main heating layer is configured to heat the wafer by heat transfer.

The edge electrostatic heating layer includes an edge insulating layer, the focus ring is overlaid on the edge insulating layer, the edge insulating layer is provided therein with a first DC electrode, and electrostatic adsorbing force is generated on the focus ring by supplying DC to the first DC electrode; and the edge insulating layer is further provided therein with a first heating element configured to heat the focus ring by heat transfer.

The main electrostatic heating layer includes an main insulating layer, the wafer is overlaid on the main insulating layer, the main insulating layer is provided therein with a second DC electrode, and electrostatic adsorbing force is generated on the wafer by supplying DC to the second DC electrode; and the main insulating layer is further provided with a second heating element configured to heat the wafer by heat transfer.

As for the electrostatic chuck mechanism according to any one of the above solutions, the edge electrostatic heating layer is provided therein with a first channel configured to deliver heat exchanging gas towards between the focus ring and the edge electrostatic heating layer.

As for the electrostatic chuck mechanism according to any one of the above solutions, the main electrostatic heating layer is provided therein with a second channel configured to deliver heat exchanging gas towards above the main electrostatic heating layer.

The electrostatic chuck mechanism according to any one of the above solutions further includes a RF source configured to supply RF energy to the wafer and the focus ring simultaneously.

The electrostatic chuck mechanism according to any one of the above solutions further includes a main RF source and an edge RF source, wherein the main RF source is configured to supply RF energy to the wafer; and the edge RF source is configured to supply RF energy to the focus ring.

The electrostatic chuck mechanism according to any one of the above solutions further includes an edge temperature sensor, a center temperature sensor and a temperature control unit, wherein the edge temperature sensor is disposed in the base and close to the edge of the wafer, and is configured to detect temperature at the edge of the wafer and send a detected temperature to the temperature control unit; the center temperature sensor is disposed in the base and close to a center of the wafer, and is configured to detect temperature at the center of the wafer and send a detected temperature to the temperature control unit; and the temperature control unit is configured to control operating state of the edge electrostatic heating layer according to the temperature at the edge to control the temperature of the focus ring, so as to control the temperature at the edge of the wafer; and is configured to control operating state of the main electrostatic heating layer according to the temperature at the center to control the temperature at the center of the wafer.

As another technical solution, the present disclosure further provides a semiconductor processing device, including a reaction chamber and an electrostatic

chuck mechanism provided in the reaction chamber, the electrostatic chuck mechanism configured to bear a wafer and adjust temperature of the wafer, wherein the electrostatic chuck mechanism employs the electrostatic chuck mechanism according to any one of the above solutions.

The present disclosure has the following beneficial effects:

The electrostatic chuck mechanism provided by the present disclosure adjusts a temperature of a wafer by providing a main electrostatic heating layer on the bearing surface of the base; and at the same time adjusts a temperature of the focus ring and further adjusts the temperature at the edge of the wafer by providing an edge electrostatic heating layer on the step surface of the base, can separately adjust the temperatures of a center area and an edge area of the wafer, so that a difference in temperature between the edge area and the center area of the wafer can be compensated for, and in turn the process uniformity can be improved. Furthermore, the main electrostatic heating layer can also electrostatically adsorb the wafer to fix the wafer; meanwhile, the edge electrostatic heating layer can electrostatically adsorb the focus ring, so that the focus ring can better fit with the edge electrostatic heating layer, thereby improving the effect of heat transfer to the focus ring.

The semiconductor processing device provided by the present disclosure can separately adjust the temperatures of a center area and an edge area of the wafer by employing the electrostatic chuck mechanism provided by the present disclosure, so that a difference in temperature between the edge area and the center area of the wafer can be compensated for, and in turn the process uniformity can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of a structure of a typical electrostatic chuck mechanism;

Fig. 2 is a cross-sectional view of an electrostatic chuck mechanism according to an embodiment of the present disclosure;

Fig. 3 is an enlarged diagram of an area I in Fig. 2; and

Fig. 4 is a schematic diagram of a partial sectional structure of an electrostatic

chuck mechanism according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

In order for a person skilled in the art to better understand technical solutions of the present disclosure, an electrostatic chuck mechanism and a semiconductor processing device according to the present disclosure are described in detail below in conjunction with the accompanying drawings.

Fig. 2 is a cross-sectional view of an electrostatic chuck mechanism according to an embodiment of the present disclosure. Fig. 3 is an enlarged diagram of an area I in Fig. 2. Referring to Figs. 2 and 3 together, the electrostatic chuck mechanism includes a base 11, an edge assembly, a main electrostatic heating layer 17 and an edge electrostatic heating layer 18. The base 11 includes: a bearing surface 111 for bearing a wafer 14; and a step surface 112 that surrounds the bearing surface 111 and is located at the edge of the wafer 14, and the step surface 112 is lower than the bearing surface 111. That is, a boss is formed in a center area of an upper surface of the base 11, an upper surface of the boss serves as the bearing surface 111 for bearing the wafer 14, and an edge area of the upper surface of the base 11, that is, the ring-shaped surface surrounding the boss, serves as the step surface 112. Generally, a diameter of the wafer 14 is slightly larger than a diameter of the bearing surface 111, and thus an edge portion of the wafer 14 extends from the boundary of the bearing surface 111 without contacting the bearing surface 111.

The edge assembly includes a focus ring 12, a base ring 13 and an insulation ring 15. The focus ring 12 is disposed on the step surface 112 in a manner of surrounding the bearing surface, and the edge portion of the wafer 14 extending from the boundary of the bearing surface 111 overlays on the focus ring 12, thereby allowing heat transfer between the focus ring 12 and the edge of the wafer 14. The base ring 13 is disposed to surround an outer peripheral wall of the base 11, and is positioned between the focus ring 12 and the insulation ring 15 in a vertical direction, and is configured to support the focus ring 12 and protect the outer peripheral wall of the base 11 from being etched by plasma. The insulation ring 15 is disposed at a bottom

of the base 11, and is fixed onto an installing and fixing member 16, and is configured to support the base 11. The focus ring 12, the base ring 13 and the insulation ring 15 may be prepared using an insulating material selected from quartz (SiO_2), ceramics (Al_2O_3), silicon carbide and the like according to requirements of different processes, and the three rings may be made of a same material or different materials.

The main electrostatic heating layer 17 is disposed on the bearing surface 111, is configured to electrostatically adsorb the wafer 14, and can adjust a temperature of the wafer 14. In the present embodiment, the main electrostatic heating layer 17 includes a main heating layer 173 and a main insulating layer 171 successively disposed from bottom to top. In a process, the wafer 14 is overlaid on the main insulating layer 171, and the main insulating layer 171 is provided therein with a second DC electrode 172, which is electrically connected to a DC power supply for supplying DC to the second DC electrode 172, so as to generate an electrostatic adsorbing force on the wafer 14 to fix the wafer 14. The main heating layer 173 is configured to heat the wafer 14 by way of heat transfer, that is, to transfer the generated heat to the wafer 14 via the main insulating layer 171. The main heating layer 173 may be bonded onto the bearing surface 111 by using silica gel.

Optionally, the main electrostatic heating layer 17 may be provided therein with a second channel (not illustrated) for delivering heat exchanging gas towards above the main electrostatic heating layer 17. Specifically, the second channel may be through holes (not illustrated) correspondingly provided in the main heating layer 173 and the main insulating layer 171 and penetrating through the thicknesses of the main heating layer 173 and the main insulating layer 171, respectively, and the through holes are configured to deliver heat exchanging gas (for example, inert gas such as helium) towards between a lower surface of the wafer 14 and an upper surface of the main insulating layer 171. The heat exchanging gas can not only accelerate heat transfer between the main insulating layer 171 and the wafer 14, but also increase uniformity of the heat transfer, thereby improving heating efficiency and heating uniformity.

The edge electrostatic heating layer 18 is disposed on the step surface 112, is

configured to electrostatically adsorb the focus ring 12, and can adjust a temperature of the focus ring 12. In the present embodiment, the edge electrostatic heating layer 18 includes an edge heating layer 183 and an edge insulating layer 181 successively disposed from bottom to top. The focus ring 12 is overlaid on the edge insulating layer 181, and the edge heating layer 183 is configured to heat the focus ring 12 by way of heat transfer, that is, to transfer the generated heat to the focus ring 12 via the edge insulating layer 181. Since the edge portion of the wafer 14 extending from the boundary of the bearing surface 111 overlays on the focus ring 12, heat can be transferred between the focus ring 12 and the edge of the wafer 14. Thus, the temperature at the edge of the wafer 14 may be adjusted indirectly by adjusting the temperature of the focus ring 12. Also, the edge insulating layer 181 is provided therein with a first DC electrode 182, which is electrically connected to a DC power supply for supplying DC to the first DC electrode 182, so as to generate an electrostatic adsorbing force on the focus ring 12, so that the focus ring 12 can better fit with the edge insulating layer 181, thereby improving the effect of heat transfer to the focus ring 12. The edge heating layer 183 may be bonded onto the step surface 113 by using silica gel.

Optionally, the edge electrostatic heating layer 18 may be provided therein with a first channel (not illustrated) for delivering heat exchanging gas towards between the focus ring 12 and the edge electrostatic heating layer 18. Specifically, the first channel may be through holes (not illustrated) correspondingly provided in the edge heating layer 183 and the edge insulating layer 181 and penetrating through the thicknesses of the edge heating layer 183 and the edge insulating layer 181, respectively, and the through holes are configured to deliver heat exchanging gas (for example, inert gas such as helium) towards between a lower surface of the focus ring 12 and an upper surface of the edge insulating layer 181. The heat exchanging gas can accelerate heat transfer between the edge insulating layer 181 and the focus ring 12, thereby improving heating efficiency.

With the main electrostatic heating layer 17 and the edge electrostatic heating layer 18, the temperatures of a center area (the portion in contact with the bearing

surface 111) and an edge area (the portion extending from the boundary of the bearing surface 111) of the wafer 14 may be separately adjusted, so that a difference in temperature between the edge area and the center area of the wafer 14 can be compensated for, and in turn the process uniformity can be improved.

Optionally, the electrostatic chuck mechanism may further include a radio frequency (RF) source (not illustrated) configured to supply RF energy to the wafer 14 and the focus ring 12 simultaneously, so as to attract plasma to move towards an upper surface of the wafer 14. Further, since RF energy is supplied to the wafer 14 while being supplied to the focus ring 12, the area of effective electric field of the wafer 14 can be increased, so that the process uniformity can be improved. The RF source generally includes an adapter and a RF power supply.

Needless to say, in practical applications, different RF sources may be employed to supply RF energy to the wafer 14 and the focus ring 12, respectively. That is, a main RF source configured to supply RF energy to the wafer 14 and an edge RF source configured to supply RF energy to the focus ring 12 may be provided separately. With the main RF source and the edge RF source, the magnitude of the RF energy supplied to the wafer 14 and the focus ring 12 may be separately controlled according to different process test requirements, so that plasma distributions in the center area and the edge area of the wafer 14 may be separately controlled, and further adjustment window of the plasma may be increased, thereby improving process uniformity.

Optionally, the electrostatic chuck mechanism may further include an edge temperature sensor, a center temperature sensor and a temperature control unit, which are not illustrated in the drawings, The edge temperature sensor is disposed in the base 11 and close to the edge of the wafer 14, and is configured to detect temperature at the edge of the wafer 14 and send the detection result to the temperature control unit. The center temperature sensor is disposed in the base 11 and close to the center of the wafer 14, and is configured to detect temperature at the center of the wafer 14 and send the detection result to the temperature control unit. The temperature control unit is configured to control operating state of the edge electrostatic heating layer 18

according to the temperature at the edge to control the temperature of the focus ring 12, so as to control the temperature at the edge of the wafer 14; and is configured to control operating state of the main electrostatic heating layer 17 to control the temperature at the center of the wafer 14. With the edge temperature sensor, the center temperature sensor and the temperature control unit, the temperatures at the center area and the edge area of the wafer 14 may be precisely controlled, respectively, so that the temperature uniformity of the wafer 14 can be further improved, and in turn the process uniformity can be improved.

It is to be noted that in the present embodiment, the edge electrostatic heating layer 18 is formed by the edge heating layer 183 and the edge insulating layer 181, but the present disclosure is not limited thereto. In practical applications, the edge electrostatic heating layer may be provided to have one edge insulating layer only, the focus ring is overlaid on the edge insulating layer, and a first DC electrode is provided in the edge insulating layer. By supplying DC to the first DC electrode, electrostatic adsorbing force is generated on the focus ring. Further, a first heating element is provided in the edge insulating layer to heat the focus ring by way of heat transfer. That is, temperature adjustment of the focus ring is achieved by embedding the heating element in the edge insulating layer. The edge electrostatic heating layer having the above structure may be manufactured by sintering.

In this case, optionally, the first channel is a through hole provided in the edge insulating layer and penetrating through the thickness of the edge insulating layer, and is configured to deliver heat exchanging gas towards between a lower surface of the focus ring and an upper surface of the edge insulating layer, so as to accelerate heat transfer between the edge insulating layer and the focus ring, thereby improving heating efficiency.

It is also to be noted that in the present embodiment, the main electrostatic heating layer 17 is formed by the main heating layer 173 and the main insulating layer 171, but the present disclosure is not limited thereto. In practical applications, the main electrostatic heating layer may be provided to have one main insulating layer only, the wafer is overlaid on the main insulating layer, and a second DC electrode is

provided in the main insulating layer. By supplying DC to the second DC electrode, electrostatic adsorbing force is generated on the wafer. Further, a second heating element is provided in the main insulating layer to heat the wafer by way of heat transfer. That is, temperature adjustment of the wafer is achieved by embedding the heating element in the main insulating layer. The main electrostatic heating layer having the above structure may be manufactured by sintering.

In this case, optionally, the second channel is a through hole provided in the main insulating layer and penetrating through the thickness of the main insulating layer, and is configured to deliver heat exchanging gas towards above the main insulating layer, i.e., towards between a lower surface of the wafer and an upper surface of the main insulating layer, so as to accelerate heat transfer between the main insulating layer and the wafer, thereby improving heating efficiency.

The temperature adjustment system of the electrostatic chuck mechanism according to an embodiment of the present disclosure is described in detail below in conjunction with Fig. 4.

As shown in Fig. 4, the electrostatic chuck mechanism according to the embodiment of the present disclosure includes a base 11 and a focus ring 12 surrounding the base 11. For convenience of description, an area corresponding to the position at which the focus ring 12 is disposed is called 'focus ring area A1', an area corresponding to the position at which the wafer is disposed is called 'wafer area A2', and the focus ring area A1 surrounds the wafer area A2.

In the present embodiment, in the focus ring area A1, the electrostatic chuck mechanism further includes a first heating layer 53, a first heating element (not illustrated), and a first heating connection element 64. The first heating layer 53 is disposed to surround the base 11 and located below the focus ring 12; the first heating element is disposed in the first heating layer 53, and is configured to heat the focus ring 12 by converting electric energy into thermal energy; and the first heating connection element 64 penetrates through the base 11 and is connected to the first heating layer 53, and is configured to input a first electric heating signal to the first heating layer 53, so that the first heating layer 53 converts the first electric heating

signal into thermal energy.

The electrostatic chuck mechanism may further include a first electrostatic layer 54, a first DC electrode 51 and a first DC electrode connection element 65. The first electrostatic layer 54 is disposed to surround the base 11 and located between the focus ring 12 and the first heating layer 53; the first DC electrode 51 is disposed in the first electrostatic layer 54; the first DC electrode connection element 65 penetrates through the base 11 and the first heating layer 53, and is connected to the first DC electrode 51 in the first electrostatic layer 54. The first DC electrode connection element 65 is configured to input a first DC voltage to the first DC electrode 51, and the first DC electrode 51 can form an electric field under the control of the first DC voltage, to enable the first electrostatic layer 54 to adsorb the focus ring 12 thereon by electrostatic adsorption, thereby fixing the focus ring 12.

The electrostatic chuck mechanism may further include a first uniform heat plate 55. The first uniform heat plate 55 is made of a material having good thermal conduction ability, and is disposed to surround the base 11 and in contact with an upper surface of the first heating layer 53, that is, the first uniform heat plate 55 is located between the first heating layer 53 and the first electrostatic layer 54. Because different positions on the focus ring 12 have different temperatures, with the first uniform heat plate 55 having good thermal conduction ability, the temperatures of the different positions of the focus ring 12 can be continuously transitioned and tend to be uniform.

The electrostatic chuck mechanism may further include a first gas channel 56. The first gas channel 56 penetrates through the first heating layer 53, the first uniform heat plate 55 and the first electrostatic layer 54, and is configured to deliver heat exchanging gas to a lower surface (i.e. back surface) of the focus ring 12, so as to form a gas layer at the lower surface of the focus ring 12. The temperature of the focus ring 12 keeps consistent with the temperature of the base 11 due to good thermal conductivity of the heat exchanging gas, that is, the temperature of the focus ring 12 is effectively controlled by increasing heat exchanging ability between the focus ring 12 and the first electrostatic layer 54. Preferably, the heat exchanging gas

may be helium, but the type of the heat exchanging gas is not limited thereto. The heat exchanging gas may be other gas, as long as heat exchange between the focus ring 12 and the first electrostatic layer 54 can be achieved, which is not described in further detail.

The electrostatic chuck mechanism may further include a first temperature control unit (not illustrated). The first temperature control unit includes a first detection module 57 and a first control module (not illustrated). The first detection module 57 is configured to detect current temperature of the focus ring 12 and send the detected temperature to the first control module; the first control module is configured to control temperature of the focus ring 12 according to the current temperature of the focus ring 12. Specifically, the first detection module 57 penetrates through the base 11, the first heating layer 53 and the first uniform heat plate 55 from the bottom of the base 11, and is in contact with the first electrostatic layer 54, to detect the current temperature of the focus ring 12, and the temperature of the focus ring 12 is controlled by the first control module. Preferably, the first detection module 57 is a thermocouple, but the first detection module 57 is not limited thereto, other temperature detecting element may be applied, which is not described in further detail.

In the present embodiment, in the wafer area A2, the electrostatic chuck mechanism further includes a second heating layer 59, a second heating element (not illustrated), and a second heating connection element 66. The second heating layer 59 is disposed on the central protruding part of the base 11; the second heating element is disposed in the second heating layer 59, and is configured to heat the wafer placed on the base 11 by converting electric energy into thermal energy; and the second heating connection element 66 penetrates through the base 11 and is connected to the second heating layer 59, and is configured to input a second electric heating signal to the second heating layer 59, so that the second heating layer 59 converts the second electric heating signal into thermal energy to heat the wafer located on the second heating layer 59. .

The electrostatic chuck mechanism may further include a second electrostatic

layer 60. The second electrostatic layer 60 is provided on the second heating layer 59, and provided therein with a second DC electrode 101. The second DC electrode 101 can form an electric field under the control of a voltage, to enable the second electrostatic layer 60 to adsorb the wafer thereon by electrostatic adsorption.

The electrostatic chuck mechanism may further include a second DC electrode connection element 67. The second DC electrode connection element 67 penetrates through the base 11 and the second heating layer 59, and is connected to the second DC electrode 101 in the second electrostatic layer 60. The second DC electrode connection element 67 inputs a second DC voltage to the second DC electrode 101, to enable the second DC electrode 101 to form an electric field under the control of the second DC voltage to adsorb the wafer.

The electrostatic chuck mechanism may further include a second uniform heat plate 61. The second uniform heat plate 61 is in contact with an upper surface of the second heating layer 59, that is, the second uniform heat plate 61 is located between the second heating layer 59 and the second electrostatic layer 60. Because different positions on the wafer have different temperatures, with the second uniform heat plate 61 having good thermal conduction ability, the temperatures at the different positions of the wafer can be continuously transitioned and tend to be uniform.

The electrostatic chuck mechanism may further include a second temperature control unit (not illustrated). The second temperature control unit includes a second detection module 62 and a second control module (not illustrated). The second detection module 62 is configured to detect current temperature of the wafer and send the detected temperature to the second control module; the second control module is configured to control temperature of the wafer according to the current temperature of the wafer. Specifically, the second detection module 62 penetrates through the base 11, the second heating layer 59 and the second uniform heat plate 61 from the bottom of the base 11, and is in contact with the second electrostatic layer 60, to detect the current temperature of the wafer, and the temperature of the wafer is controlled by the second control module. Preferably, the second detection module 62 is a thermocouple, but the second detection module 62 is not limited thereto, other temperature detecting

element may be applied, which is not described in further detail.

The electrostatic chuck mechanism may further include a second gas channel 58. The second gas channel 58 penetrates through the base 11 from the bottom of the base 11, to deliver heat exchanging gas to a lower surface (i.e. back surface) of the wafer, so as to form a gas layer at the lower surface of the wafer. The temperature of the wafer keeps consistent with the temperature of the electrostatic chuck mechanism due to good thermal conductivity of the heat exchanging gas, that is, the temperature of the wafer is effectively controlled by increasing heat exchanging ability between the wafer and the second electrostatic layer 60. Preferably, the heat exchanging gas may be helium, but the type of the heat exchanging gas is not limited thereto. The heat exchanging gas may be other gas.

In the present embodiment, the first gas channel 56 and the second gas channel 58 communicate with each other, that is, the first gas channel 56 and the second gas channel 58 have a same gas inlet. The first gas channel 56 is configured to introduce heat exchanging gas from the gas inlet to the lower surface of the focus ring 12 to control the temperature of the focus ring 12; and the second gas channel 58 is configured to introduce the heat exchanging gas from the gas inlet to the lower surface of the wafer to control the temperature of the wafer. The first gas channel 56 and the second gas channel 58 can be simplified in structure by making the first gas channel 56 and the second gas channel 58 communicate with each other.

The electrostatic chuck mechanism may further include a heat medium flow channel 63. The heat medium flow channel 63 is disposed in the base 11, and distributed in both the focus ring area A1 and the wafer area A2. Heat medium fluid for maintaining basal temperature of the base 11 may be supplied into the heat medium flow channel 63. The heat medium flow channel 63 is connected to a heat medium entrance 68 configured to introduce heat medium fluid in or out of the heat medium flow channel 63.

The electrostatic chuck mechanism may further include a RF electrode input terminal 69. The RF electrode input terminal 69 is connected to the base 11, and in a process, the RF electrode input terminal 69 can introduce RF energy into the

electrostatic chuck mechanism.

In the electrostatic chuck mechanism according to the present embodiment, a focus ring 12 is disposed to surround the base 11, a first heating layer 53 is disposed to surround the base 11 and below the focus ring 12, a first heating element is disposed in the first heating layer 53, and the first heating element is connected to an external power supply via a first heating connection element 64 penetrating through the base 11, so as to heat the focus ring 12 by generating thermal energy from electric energy. By separately heating the focus ring 12, the temperature of the focus ring 12 may be controlled more precisely, thereby reducing temperature difference between the edge area and the center area of the wafer.

As another technical solution, an embodiment of the present disclosure further provides a semiconductor processing device, which includes a reaction chamber and an electrostatic chuck mechanism provided in the reaction chamber. The electrostatic chuck mechanism is configured to bear a wafer and adjust temperature of the wafer. The electrostatic chuck mechanism employs the electrostatic chuck mechanism according to the embodiments of the present disclosure.

The semiconductor processing device provided by the embodiment of the present disclosure can separately adjust the temperatures of a center area and an edge area of the wafer by employing the electrostatic chuck mechanism according to the embodiment of the present disclosure, so that a difference in temperature between the edge area and the center area of the wafer can be compensated for, and in turn the process uniformity can be improved.

It could be understood that the foregoing implementations are exemplary implementations merely used for illustrating the principle of the present disclosure, but the present disclosure is not limited thereto. A person of ordinary skill in the art may make various variations and modifications without departing from the spirit and essence of the present disclosure, and these variations and modifications are also considered to fall within the protection scope of the present disclosure.

What is claimed is:

1. An electrostatic chuck mechanism, comprising a base and an edge assembly, wherein the base comprises a bearing surface configured to bear a wafer and a step surface surrounding the bearing surface and located at an edge of the wafer, the step surface being lower than the bearing surface; the edge assembly comprises a focus ring, a base ring, and an insulation ring, the focus ring is disposed on the step surface in a manner of surrounding the bearing surface; the base ring is disposed to surround an outer peripheral wall of the base; the insulation ring is disposed at a bottom of the base and supports the base; characterized in that, the electrostatic chuck mechanism further comprises a main electrostatic heating layer and an edge electrostatic heating layer, wherein,

- the main electrostatic heating layer is disposed on the bearing surface, configured to electrostatically adsorb the wafer; and

- the edge electrostatic heating layer is disposed on the step surface, configured to electrostatically adsorb the focus ring, and is able to adjust temperature of the focus ring;

- the edge electrostatic heating layer comprises an edge heating layer and an edge insulating layer successively disposed from bottom to top, wherein

- the focus ring is overlaid on the edge insulating layer, the edge insulating layer is provided therein with a first DC electrode, and electrostatic adsorbing force is generated on the focus ring by supplying DC to the first DC electrode; and

- the edge heating layer is configured to heat the focus ring by heat transfer.

2. The electrostatic chuck mechanism according to claim 1, characterized in that, the main electrostatic heating layer comprises a main heating layer and a main insulating layer successively disposed from bottom to top, wherein

- the wafer is overlaid on the main insulating layer, the main insulating layer is provided therein with a second DC electrode, and electrostatic adsorbing force is generated on the wafer by supplying DC to the second DC electrode; and

the main heating layer is configured to heat the wafer by heat transfer.

3. The electrostatic chuck mechanism according to claim 1, characterized in that, the edge insulating layer is further provided therein with a first heating element configured to heat the focus ring by heat transfer.

4. The electrostatic chuck mechanism according to claim 1, characterized in that, the main electrostatic heating layer comprises an main insulating layer, the wafer is overlaid on the main insulating layer, the main insulating layer is provided therein with a second DC electrode, and electrostatic adsorbing force is generated on the wafer by supplying DC to the second DC electrode; and

the main insulating layer is further provided therein with a second heating element, configured to heat the wafer by heat transfer.

5. The electrostatic chuck mechanism according to any one of claims 1 to 4, characterized in that, the edge electrostatic heating layer is provided therein with a first channel configured to deliver heat exchanging gas towards between the focus ring and the edge electrostatic heating layer.

6. The electrostatic chuck mechanism according to any one of claims 1 to 4, characterized in that, the main electrostatic heating layer is provided therein with a second channel configured to deliver heat exchanging gas towards above the main electrostatic heating layer.

7. The electrostatic chuck mechanism according to any one of claims 1 to 4, characterized in that, the electrostatic chuck mechanism further comprises a RF source configured to supply RF energy to the wafer and the focus ring simultaneously.

8. The electrostatic chuck mechanism according to any one of claims 1 to 4, characterized in that, the electrostatic chuck mechanism further comprises a main RF

source and an edge RF source, wherein

the main RF source is configured to supply RF energy to the wafer; and
the edge RF source is configured to supply RF energy to the focus ring.

9. The electrostatic chuck mechanism according to any one of claims 1 to 4, characterized in that, the electrostatic chuck mechanism further comprises an edge temperature sensor, a center temperature sensor and a temperature control unit, wherein

the edge temperature sensor is disposed in the base and close to the edge of the wafer, and is configured to detect temperature at the edge of the wafer and send a detected temperature to the temperature control unit;

the center temperature sensor is disposed in the base and close to the center of the wafer, and is configured to detect temperature at the center of the wafer and send a detected temperature to the temperature control unit; and

the temperature control unit is configured to control operating state of the edge electrostatic heating layer according to the temperature at the edge to control the temperature of the focus ring, so as to control the temperature at the edge of the wafer; and configured to control operating state of the main electrostatic heating layer according to the temperature at the center to control the temperature at the center of the wafer.

10. A semiconductor processing device, comprising a reaction chamber and an electrostatic chuck mechanism provided in the reaction chamber, the electrostatic chuck mechanism configured to bear a wafer and adjust temperature of the wafer, characterized in that, the electrostatic chuck mechanism employs the electrostatic chuck mechanism according to any one of claims 1 to 9.